active

RESEARCH MEMORANDUM

for the

Air Materiel Command, Army Air Forces

INVESTIGATIONS OF TUMBLING CHARACTERISTICS OF A 1/20-SCALE

MODEL OF THE NORTHROP N-9M AIRPLANE

Br

George F. MacDougall, Jr.

Langley Memorial Aeronautical Laboratory Landley Field. Va.



NATIONAL ADVISORY COMMITTEE NACA LIBRARY FOR AERONAUTICS

JAN 27 1947 LANGLEY MEMORIAL AFRONAUTICAL
LABORATORY

SATURDAY TAL

UNCLASSITUT

NACA RM No. L6L10

COMPARED TAL

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

3 1176 01437 0994

for the

Air Materiel Command, Army Air Forces

INVESTIGATIONS OF TUMBLING CHARACTERISTICS OF A 1/20-SCALE

MODEL OF THE NORTHROP N-9M AIRPLANE

By George F. MacDongall, Jr.

SUMMARY

The tumbling characteristics of a 1/20-scale model of the Northrop N-SM airplane have been determined in the Langley 20-foot free-spinning tunnel for various configurations and loading conditions of the model. The investigation included tests to determine whether recovery from a tumble could be effected by the use of parachutes. An estimation of the forces due to acceleration acting on the pilot during a tumble was made. The tests were performed at an equivalent test altitude of 15,000 feet.

The results of the model tests indicate that if the airplane is stalled with its nose up and near the vertical, or if an appreciable amount of pitching rotation is imparted to the airplane as through the action of a strong gust, the airplane will either tumble or oscillate in pitch through a range of angles of the order of t120°. The normal flying controls will probably be ineffective in preventing or in terminating the tumbling rotion. The results of the model tests indicate that deflection of the landing flaps full down immediately upon the initiation of pitching rotation will tend to prevent the development of a state of tumbling equilibrium. The simultaneous opening of two 7-foot diameter parachutes having drag coefficients of 0.7, one parachute attached to the rear portion of each wing tip with a towline between 10 and 30 feet long, will provide recovery from a tumble. The accelerations acting on the pilot during a tumble will be dangerous.

INTRODUCTION

At the request of the Air Materiel Command, Army Air Forces, tests were performed in the Langley 20-foot free-spinning tunnel to determine the spin and recovery characteristics and the tumbling (a continuous rotation about the lateral axis of the airplane) characteristics of a 1/20-scale model of the Northrop N-9M airplane. The results of the spin-recovery tests have been presented in reference 1, and the results of the tumbling tests are presented herein.

The airplane represented by the model is a twin-engine. flyingwing airplane equipped with pusher propellers. The airplane was constructed and flown to provide data for use in the development of the Northrop XB-35 airplane and was approximately one-third the size of the XB-35. Directional control on the N-9M airplane is obtained by wing tip control surfaces designated by Northrop Aircraft. Inc. as "scoop rudders" and "pitch flaps." The scoop rudders are installed on the lower surface of the wing just forward of the leading edge of the pitch flaps. The pitch flaps are trailing edge flave and are deflected up when the scoop rudders move down. The pitch flaps are also used as a longitudinal trim device when the landing flaps are deflected. Longitudinal and lateral control are obtained with trailing-edge flaps designated by Northrop Aircraft, Inc. as "elevons." The elevons serve as both elevators and ailerons and are located just inboard of the directional control devices. Landing flaps are installed along the trailing edge of the wing between the plane of symmetry and the inboard end of the elevons.

The tumbling characteristics of the model were investigated for a basic leading designated by Northrop Aircraft, Inc. as flight test condition number one and also with the center of gravity moved forward. Tests were performed to determine the individual effects of deflecting the landing flaps, of extending the landing gear, and of deflecting the pitch flaps. The fin effect of windmilling propellers was ascertained from tests with horizontal and vertical equivalent propeller fin area installed. At the request of Northrop Aircraft, Inc., tests were performed with 20-percent and with 35-percent span auxiliary leading-edge slats installed and also with XB-35 type split rudders installed on each wing tip and opened simultaneously to determine the effect

of these design modifications on the tumbling characteristics of the model. The effect of installing various amounts of horizontal area on a boom rearward of the model was investigated and tests were performed to determine whether recovery from a tumble could be effected by the use of parachutes. Approximate calculations were made of the forces that would be acting on the pilot's head when the airplane is tumbling.

SYMBOLS

ъ	wing spen, feet
S	wing area, square feet
c	wing chord at any station along the span
č	mean aerodynamic chord, feet
x /c̄	ratio of distance of center of gravity rearward of leading edge of mean aerodynamic chord to mean aerodynamic chord
z/ē	ratio of distance between center of gravity and root chord line to mean aerodynamic chord (positive when center of gravity is below root chord line)
m	mass of airplane, slugs
IX, IY, IZ	moments of inertia about X, Y, and Z body axes, respectively, slug-feet2
$\mathbf{I}_{\mathbf{X}}$, $\mathbf{I}_{\mathbf{Y}}$, $\mathbf{I}_{\mathbf{Z}}$	moments of inertia about X, Y, and Z body axes,
_	moments of inertia about X, Y, and Z body axes, respectively, slug-feet2 distance from axis of tumbling rotation to pilot's
R	moments of inertia about X, Y, and Z body axes, respectively, slug-feet ² distance from axis of tumbling rotation to pilot's head, feet full-scale rate of pitching rotation during tumble,
R q	moments of inertia about X, Y, and Z body axes, respectively, slug-feet ² distance from axis of tumbling rotation to pilot's head, feet full-scale rate of pitching rotation during tumble, radians per second acceleration due to gravity, approximately 32.2 feet

APPARATUS AND METHODS

Models

The 1/20-scale model of the Northrop N-9M airplane previously used for the spin tests reported in reference 1 was also used for the tumbling tests. Because of difficulties encountered in performing the tumbling tests, a second model was constructed and prepared for testing by Langley to expedite the test program. Dimensional and mass characteristics of the airplane represented by the models are given in table I and a three-view drawing of the models as tested in the clean configuration (flaps neutral and landing gear retracted) is presented as figure 1. Figures 2 and 3 are photographs of one of the models in the clean and landing configurations, respectively. The models were ballasted as described in reference 1 to obtain dynamic similarity to the airplane at an altitude of 15,000 feet (p = 0.001496 slug per cubic foot). A remote-control mechanism was mounted in one of the models to open the parachutes for recovery tests. The parachutes used were of the flat circular type, made of silk, and had a drag coefficient of approximately 0.7 based on the surface area of the canopy when spread out flat. The auxiliary leading-edge slats and equivalent propeller fin area used for the tumbling tests were the same as those used for the spin tests reported in reference L and are shown on figures 4 and 5, respectively. Tests were performed with horizontal areas equal to 2 percent (previously used for spin tests), 5 percent, and 10 percent of the wing area installed on a boom rearward of the model as shown on figure 6. The installation of the XB-35 type split rudders and a comparison of the XB-35 type rudder controls with the N-9M rudder controls are presented on figure 7.

Wind Tunnel and Testing Technique

The tumbling tests were performed in the Langley 20-foot free-spinning tunnel, the operation and design of which is generally similar to that of the 15-foot free-spinning tunnel as described in reference 2. Various methods of launching were employed in the tumbling tests. In order to determine whether the model would start tumbling of its own accord, the model was released without rotation either from an attitude in which the model was approximately horizontal, from an attitude in which the nose was approximately 70° below the horizontal, from an attitude in which the model was approximately vertical with the nose up or was impelled into the tunnel without rotation with the nose slightly above the horizontal.



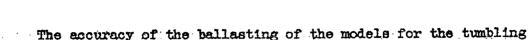
In order to determine whether the model would stop tumbling once the tumbling motion had been started, the model was launched into the tunnel by hand with either positive or negative pitching rotation. The tumbling tests in which the model was released without rotation were arbitrarily performed at a constant tunnel airspeed of approximatly 75 feet per second and those in which the model was launched with rotation were arbitrarily performed at a constant airspeed of approximately 65 feet per second. The initial pitching rotation imparted to the model for the tests in which it was launched with rotation was sufficient to tumble the model through one to three complete revolutions. For the cases in which the model would tumble, it could make only five to six complete tumbles before traveling across the tunnel and hitting the safety net on the opposite side.

Motion pictures were taken of the tests so that a study could be made of the motion of the model during the tumble and, for those cases for which the model would not tumble, of the motion after launching. An approximation of the vertical rate of descent of the model during a tumble was determined from film records of the tests and from the tunnel airspeed. The camera speed being known, the apparent vertical rate of descent was determined from the number of frames of film in which the model moved a certain vertical distance in the tunnel. This apparent vertical rate of descent was added to the tunnel airspeed to give an approximation of the vertical rate of descent of the model during the tumble. An approximation of the horizontal component of velocity during a tumble was obtained from the film records in a manner similar to that for the vertical component.

The model was launched into the tunnel with initial positive pitching rotation for the tests made to determine whether recovery from a tumble could be effected by the use of parachutes. The parachutes were opened for recovery approximately two complete tumbles after the model was launched. For some of the tests, parachutes installed on both wing tips were opened simultaneously whereas for other tests only the parachute on one wing tip was opened. The parachutes were installed on the model as described in reference 1 for the spin tests. The points of attachment for the parachute towlines are shown in figure 8.

PRECISION

The measurement of the rate of rotation and of the vertical and horizontal velocity components of the path of the model while tumbling are believed to be accurate within limits of ±5 percent and ±10 percent, respectively.



tests was the same as that reported in reference 1 for the spin tests. The controls were set with an accuracy of tlo.

TEST CONDITIONS

The conditions tested in the investigation to determine the tumbling characteristics of the models are listed in table II. Full-scale values of mass parameters for the loadings tested on the models and for various loading conditions of the airplane are given in table III. As previously mentioned, the basic test condition was designated as flight test condition number one, and in addition, tests were made with the center of gravity moved forward 5 percent of the mean aerodynamic chord. For each test condition, various eleven positions including neutral and maximum deflections for longitudinal and lateral control were investigated.

The N-9M airplane is equipped with a wheel mounted on top of a stick to move the elevons for longitudinal and lateral control. Longitudinal movement of the stick and wheel moves both elevons either up or down together for longitudinal control whereas. turning the wheel moves one elevon up and the other elevon down for lateral control. Although there was no stick or wheel in the models, control deflections are generally referred to herein in terms of stick and wheel positions. The elevon deflections were the same as those given in reference 1 for the spin tests and are presented on figure 9. The scoop rudders were maintained at neutral throughout the entire test program. The pitch flaps were neutral except when the model was in the landing configuration and for a few tests in which both pitch flaps were set 26° up in order to determine the effect of pitch flap deflection on the tumbling characteristics of the model. The pitch flaps were removed from both wing tips and XB-35 type split rudders were installed for tests to determine whether this type of rudder control. acting in a manner similar to that of dive brakes, would have an . effect on the tumbling characteristics of the model. The split rudders on each wing tip were open simultaneously ±60° for these tests. Unless otherwise specifically stated in the discussion. the model was in the clean configuration and ballasted to represent flight test condition number one.

RESULTS AND DISCUSSION

As previously mentioned, for convenience, two models of the N-9M airplane were used in the tumbling investigation. The results

of preliminary tests indicated that both models had similar tumbling characteristics. The results are presented herein therefore without regard to the particular model used.

7

Interpretation of Results

Inasmuch as no data on the tumbling of full-scale aircraft are available, the accuracy of predicting airplane tumbling characteristics from model data is unknown. In applying the model results to the full-scale airplane the following interpretation has been placed on the results from different methods of launching the model.

When launched into the tunnel, either with or without initial pitching rotation, the model either would or would not tumble. If the model tumbled with either method of launching it was taken as an indication that the corresponding airplane could tumble, although the airplane probably would be more likely to tumble if the model started tumbling when launched with no pitching rotation. If the model stopped tumbling after being launched with initial pitching rotation, the results were interpreted to mean that the corresponding airplane would not tumble.

Clean Configuration

Flight test condition number one. In general, the model continued to tumble when launched with either initial negative or positive pitching rotation regardless of elevon deflection (table IV-A) thereby indicating that elevon deflection had no appreciable effect on the tumbling characteristics of the model. For a typical tumble, the vertical component of velocity was approximately 150 feet per second, full scale, the horizontal component of velocity was approximately 75 feet per second, full scale, and the rate of rotation was approximately 1 rps, full scale. The components of velocity and the rate of rotation were obtained from the film records as previously described and are shown graphically on figure 10.

When released from a nose-up vertical attitude (table V-A), the model sometimes started to tumble and at other times oscillated in pitch through a range of approximately \$1200\$ measured from the nose-down position. These oscillations appeared to be only lightly damped before the model reached the safety net at the bottom of the tunnel. Figures 11 and 12 are reproductions of motion-picture records of a typical tumble and of a typical oscillatory motion, respectively, when the model was released from a vertical attitude with its nose up. It appears from the

results of these tests that the airplane may start to tumble if it is stalled with its nose up near the vertical or if it is forced into a nose-up attitude by a strong gust.

The model dived into the safety net with oscillations in pitch of the order of t15° when released from an attitude with its nose approximately 70° below the horizontal (table VI-A). When the model was released from a horizontal attitude (table VI-B), it made one or two oscillations in pitch of approximately t40° and then dived with the oscillations rapidly diminishing in amplitude. The motion of the model when impelled into the tunnel with the nose of the model slightly above the horizontal (table VII) was generally similar to that when it was released from a horizontal attitude. From the results of the tests with these latter three types of launchings, it appears that the airplane will not start tumbling when it is stalled with its nose slightly above the horizontal or when it is in a dive.

Inasmuch as the model did not start tumbling for the clean configuration, flight test condition number one, as previously mentioned, when it was released from a horizontal attitude, when it was released with its nose 70° below the horizontal, or when it was impelled into the tunnel with its nose slightly above the horizontal, it was believed that the model also would not tumble for any of the remaining configurations and loadings on the test program when it was launched in any of these three manners. These methods of launching, therefore, were not employed for the remainder of the test program.

Equivalent fin effect of propellers. The results of the tests with propellers simulated which are presented on tables IV-B and V-B were generally similar to those obtained without the propeller fin area and thereby indicate that the fin effect of the propellers was not sufficiently large to appreciably effect the tumbling characteristics of the model.

Center of gravity forward. The results presented on tables IV-C and V-C indicate that movement of the center of gravity 5 percent of the mean aerodynamic chord forward of normal had a somewhat beneficial effect on the tumbling characteristics of the model. Then launched with initial negative pitching rotation (nose down), the model usually stopped tumbling and made two oscillations in pitch of approximately 1120° after which the oscillations started to damp out. No appreciable effect of center-of-gravity location was noticed, however, when the model was launched with initial positive pitching rotation. When released from a vertical attitude with its nose up, the model oscillated in a manner generally

similar to that previously described for launchings with initial negative pitching moment. It is believed that the decreased tendency of the model to tumble with the center of gravity forward can be attributed to the increase in longitudinal stability associated with the forward movement of the center of gravity.

Auxiliary Slats Installed

Installation of 20-percent span auxiliary leading-edge slats had little effect on the tumbling characteristics when the model was launched with initial pitching rotation. (See table IV-D.) When the model was released at a vertical attitude with its nose up, however, the tendency of the model to start tumbling was diminished and the amplitude of the oscillations in pitch was decreased. (See table V-D.) Installation of 35-percent span auxiliary leading-edge slats had a somewhat teneficial effect on the tumbling characteristics of the model in that the model would not now continue tumbling after being launched with initial negative pitching rotation when the stick was back. (See table IV-E.) There was also a reduced tendency for the model to continue tumbling when the stick was forward for launchings with either initial negative or positive ritching rotation. The results on table V-E also show that for launchings from a nose-up vertical attitude, the model exhibited less tendency to tumble, and the oscillations in pitch damped out more rapidly when the 35-percent span slats were installed than when the model was in the original configuration.

XB-35 Type Split Rudders Installed

The results on table IV-F show that installation of the XB-35 type split rudders had no appreciable effect on the tumbling characteristics of the model when launched with initial pitching rotation. A somewhat favorable effect of installing the split rudders was noticed when the model was released from a vertical attitude with its nose up in that the model generally would not now tumble. (See table V-F.)

Landing Configuration

The results obtained with the model in the landing configuration (landing gear extended, landing flaps 50° down, and pitch flaps 26° up) were generally similar to those for the clean configuration when the model was launched with either positive or negative initial pitching rotation. (See table IV-G.) A favorable effect of the landing configuration was observed, however, when the model was released from a nose-up vertical attitude. For this latter type of launching, the model made one or two oscillations in pitch of the order of ±120° after which the oscillations damped out and the model then dived to the safety net. (See table V-G.)

Tests were next performed to ascertain the contribution of the landing flaps, the landing gear, and the pitch flaps in preventing the model from tumbling, and in reducing the amplitude of the oscillations in pitch, when released from a nose-up attitude in the landing configuration. The results of these tests are presented on table V-H through V-K and indicate that the deflection of the landing flaps was the main factor in preventing the establishment of a state of tumbling equilibrium and of reducing the amplitude of the oscillations in pitch when the model was in the landing configuration.

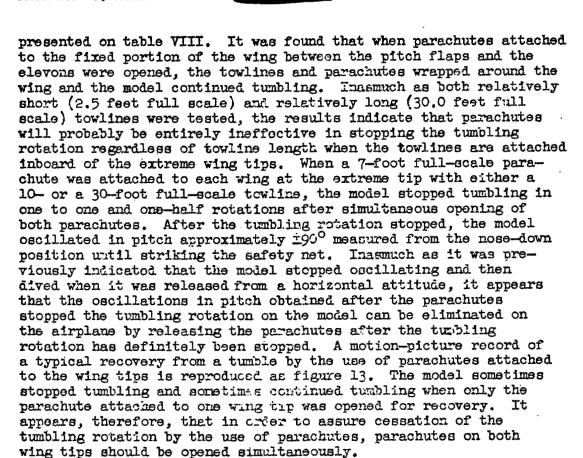
Horizontal Area Installed Rearward of the Model

Installation of horizontal area rearward of the model had a beneficial effect on the tumbling characteristics of the model. When launched with either initial positive or negative pitching rotation with horizontal area equal to either 10 percent or to 5 percent of the wing area installed on a boom rearward of the model, the model stopped tumbling, made two or three oscillations in pitch of rapidly diminishing amplitude, and then dived to the safety net for all stick - wheel positions. (See table IV-H and IV-I.) Installation of horizontal area equal to 2 percent of the wing area, however, had no appreciable effect on the tumbling characteristics of the model when the model was launched with initial pitching rotation. (See table IV-J.)

The model would not start tumbling when released from a nose-up vertical attitude when any one of the three previously mentioned horizontal areas were installed. (See table V-L, V-M, and V-N.) After release from the nose-up attitude, the model made two or three oscillations in pitch of diminishing amplitude and then dived down into the safety net. The reduced tendency of the model to tumble and to oscillate in pitch with horizontal area installed may be explained on the basis of an increase in longitudinal stability contributed by the horizontal area.

Parachutes

The results of the tests performed to determine whether the tumbling rotation could be stopped by opening parachutes are



Prevention and Termination of Tumbling

The results presented herein show that the normal flying controls of the Northrop N-GM airplane will probably be ineffective in preventing or in terminating the tumbling rotation. It has been indicated, however, that deflection of the landing flaps full down before the tumbling rotation has been established may prevent the development of a stable tumcling condition.

The results presented herein have also shown that the airplane probably will not start tumbling unless it is stalled at a nearly vertical attitude with its nose up or is forced into a tumble, as by a strong gust. It is recommended therefore that care be exercised when maneuvering to avoid stalling the airplane with its nose up near the vertical. If the airplane is to be flown through maneuvers in which the nose becomes nearly vertical, it is recommended that parachutes be installed for emergency recovery from a tumble. A satisfactory parachute installation

for recovery from a tumble consists of a parachute at least 7 feet in diameter mounted either inside the structure with provisions for positive ejection or on the upper surface of each wing tip. The parachutes should be attached to the rear portion of the respective wing tip with a towline between 10 and 30 feet long and should be opened simultaneously for recovery if the airplane starts to tumble.

If the airplane is inadvertently stalled with its nose up and near the vertical, the landing flaps should immediately be deflected full down as rapidly as possible in an attempt to provent the establishment of a stable tumbling condition. If the landing flaps are deflected full down before the airplane has fallen off appreciably from the stall, the airplane will not tumble but will make a few oscillations in pitch on the order of £120° after which the oscillations will damp out. The stick should be moved in a direction such as to counteract the pitching motion in order to decrease the time required for the oscillations to damp out.

Accelerations in a Tumple

Approximate calculations were made to determine the accelerations acting on the pilot's head during a typical tumble for flight test condition number one. The accelerations were considered to be caused only by the rotation about the lateral axis, the effect of the vertical and horizontal motions being neglected. The axis of tumbling rotation was assumed to be at the center of gravity making the radius from the axis of tumbling rotation to the pilot's head approximately 3.5 feet. The full-scale rate of rotation was approximately 6.3 radians per second. When only the acceleration due to rotation (q2R) is considered, it appears that an acceleration of approximately 4.3g would be acting on the pilot's head during a typical tumble. Reference 3 indicates that positive accelerations (such as to push the pilot down in the seat) of 5g will probably cause temporary loss of vision and that forces of 6 to 7g will cause loss of consciousness. It is further pointed out in reference 3 that negative accelerations of three times the pull of gravity will cause symptoms of concussion of the brain and that negative accelerations of 5g may result in massive cerebral hemorrages and death. It thus appears that if the airplane tumbles, the pilot may be in acute physical danger as a result of the accelerations created by the tumbling rotation, especially if the airplane tumbles in a direction such as to cause negative accelerations to act on his body and head.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the results of the tumbling tests of a 1/20-scale model of the Northrop N-9M airplane, the following conclusions and recommendations regarding the tumbling characteristics of the airplane at an altitude of 15,000 feet are made.

- 1. If the airplane is stalled with its nose up and near the vertical or if an appreciable pitching rotation is imparted to the airplane as by a gust when it is in the clean configuration for flight test condition number one, it will either start tumbling or will oscillate in pitch through a range of angles of the order of ±120° from the nose-down position. The normal flying controls will probably be ineffective either in preventing the tumble or in producing recovery once a tumble has started.
- 2. Immediate deflection of the landing flaps full down when the airplane is stalled with its mose up near the vertical will prevent the airplane from tumbling and will reduce the tendency of the airplane to oscillate in pitch after nosing down from the stall.
- 3. Simultaneously opening two parachules 7 feet in diameter and having a drag coefficient of 0.7, one parachute attached to the rear portion of each wing tip, will effect recovery from a tumble.
- 4. Installation of a horizontal tail of the order of 5 percent of the wing area rearward of the airplane will provent the airplane from tumbling.
- 5. The tendency of the airplane to tumble and to oscillate in pitch will not be as great when the center of gravity is forward approximately 5 percent of the mean aerodynamic chord as when the center of gravity is in its normal location for flight test condition number one. The tendency of the airplane to tumble will also be reduced when leading-edge slats are installed.

6. The accelerations acting at the pilot's head during a tumble will be dangerous, especially when acting in a negative direction.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va.

George F. MacDougall, Jr.
Aeronautical Engineer

Approved:

Handley a. Souls

Hartley A. Soule

Chief of Stability Research Division

CCB

REFERENCES

- 1. MacDougall, George F., Jr. and Lichtenstein, Jacob H.: Free-Spinning-Tunnel Tests of a 1/20-Scale Model of the Northrop N-9M Airplane. NACA RM No. 16G30, Army Air Forces, 1946.
- 2. Zimmerman, C. H.: Preliminary Tests in the N.A.C.A. Free-Spinning Wind Tunnel. NACA Rep. No. 557, 1936.
- 3. Armstrong, Harry G. and Heim, J. W.: The Effect of Acceleration on the Living Organism. ACTR No. 4362, Materiel Div., Army Air Corps, Dec. 1, 1937.

TABLE I .- DIMENSIONAL CHARACTERISTICS OF THE

NORTHROP N-9M AIRPLANE

Length over	all,	ft	•		•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	17	.78
Propellers,	type		•		•	•	•	•	•	•	•	•	•	•	•	٠	•	•	•	•	•	Ι	usk	ıer
Propellers,	diame	eter	', f	t.	•	•	٠	•	•	•	•	•	•	•	•	•	•	•	•	٠	•	•	7	.00
Propellers,	numbe	er.			•	•	•	•	•	•		•	•	•	•	•	•	•	٠	•	•	•		. 2
Propellers,	blade	9 8 C	n e	ach	•	•	•	•	•	•	٠	•	•	•	•	•	•	•	•	•	•	•	•	. 2
Wing:																								
Span, ft																	•						60.	.00
Area, sq	ft .																						490	0.0
Section,	root																		MA	CA	-6	5.	3-0	Ľ
Section,	tin .				•			•		•	•							•	NA	CA	-6	, 5	3-0	۶1ε
Twist, ti	n lead	 Itno	. 68	TO.	d Or	ית	• 4	60	•	•	•	•	•	•	•	•	•	•	112	102		,,	1	
Titlet, or	b rear			<u>ვ</u> ნ იხი	~~?	, 117 1 1 1 1	~ u	.56	۶ م د		•	•	•	•	•	•	•	•	•	•	•	•	• 7	, .C
Dihedral,																								
Aspect ra																								
Taper rat																								
Sweepback	, 25]	perc	ent	ch	orc	1	.in	e,	đ	.ee	ŝ	•	•	•	•	•	•	٠	•	٠	•	•	21	٠٠۶
Mean aero																			•	•	•	•	109	3.6
Leading e	dge of	l'me	en	aer	odj	ma	mi	C	ch	or	ð	re	a	7/2	110	Lc	f							
leading	edge	of	roo	t c	hoi	″ી,	1	n.		•	•	•	•	•	•	•	•	٠	•	•	•	•	69	.7
Elevons:																								
Chord rea	rward.	of	hin	ge	11r	ıe.	f	t									•						1.	57
Span, per	cent o	of w	dna	ັສນ	an	.′																	3:	₹.6
Area rear	ward o	of h	ing	e Î	ine	٠.	Dе	130	er	ıt.	of	, _T	rtr	7	a.	ee	<u>.</u>						ĕ	5.5
		, <u>.</u> .		-		• •	20				-	•	•	•			•	٠	•	•	٠	•	•	•
Pitch flaps																								
Chord, pe	rcent	of	win	g c	hor	rđ.						•	•		•	٠	٠	•	•	•	•	•	21	1.2
Span, per	cent o	of w	ring	gp	an																		23	3.6
Area rear																								
Scoop rudde	re:																							
Span, per		הר ש	ri ng	gn	คท																_		21	_=
-		N	~~~	~p	-4.2	٠	•	•	•	•	•	•	•	•	•	•	•	٠	٠	٠	•	•		/
Landing fla	ps:																							
Span, per	cent o	of w	ring	ap	en					•							•	•					35	5.3
Total are																								

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS



TABLE II - CONDITIONS TESTED IN THE INVESTIGATION OF THE THREEDS CHARACTERISTICS OF THE 1/20-SCALE MODELS OF THE MORTHROY NI-OM ALBOLAND

Ħa.	Change from criginal, clean configuration	Loading	Type of Laurahine	Lentin flape	Pitch flaps (deg)	Landing	Slots	E-ritenta area	Split rudders	Parachute etrached	Data presented on table
1	Fcne	Flight test condi- tion number 1	With initial pitchine	Wentrel	ı o	Retroated	Tone	None	Jene	I'ne	17-A
3			Released from mee-up vertical attitude		. 0	do	-do-	 do			V-A
3		do	Released with nose empor- imately 70° below	ac	•		-ab-	40	1		VI-A
		do	horizontal Beleased from herisonsal attitude	00		ao	-do-	do	to		77-3
`	do	-	Impelled into smal with nose slightly shows	do	0	10	-to-	do		&	VIII
	Equivalent propeller fin area installed		horizontal With initial ptobing rotation	to	۰	-e o	-do-	do			X7-3
7		to	Released from nose-up vertical attitude	4c	0		-ao-	to		40	V-3
•	los:	Center of gravity 5 percent 6 forward of morsal location for flight test condition	With initial pitching rotation	40	٥		-do-	do			14-C
٩		number 1	Released from sor-We	40		da	-40	40			
10	30-percent snen suriliary leading- edge slats installed	Flight test condition number 1	vertical attitude With initial problem rotation		٥	-to-	Open -		ŧ .	dc	V-C
11	do		Belesset from mon-up	امه	0	do	-ao -	do			₹-D
12	"-percent span nurlliary leading- edge slats installed	do	Fith initial pitches	to	•	···-do	مه-		do	do	IV-B
13			Beleased from xxx 100 vertical attitude	مه	0 -	·do	- a o -	60	do	مه	T-2
14	C3-35 type split rudders installed		Fith initial picking rotation		°	مه	Some -	do	both wing	to	IT-F
15	do		Beleased from now-up vertical attitude	to	•	t o	-4 0		tipe 600 on both wing	do	V-3
16	Landing	I	Vith initial pitching rotation	50° does 2	- 1	2:: *ed -	مه	···• 6 0	tipe Rome	do	IY-G
17		do	Released from most up vertical attitude	ab 2	6 - - -		م ه		مه	40	¥-G
	Lending flaps deflected and landing gear extended	do		do	°	to	ob	·to	do	40	V-E
	Loding flaps ieflected	do			- 1	- 1	مه	do -		to	▼- I
2C	extended			Houtral			-		- 1	do	¥-J
I I	Pitch flage deflected Borisontal area		Vitta infal pitching	do 2	- 1	1	- 1				₹-₹
22	installed		rotata		•	10	E DE	nel to - 10 per- cent of wing	do		IV-E
23	to		Released from more vertical attitude		۰	10	مه	do	do		V-L
34			with initial pitching rotation	do	•		do Bq	" per- cent of wing			IV-I
8		to	Released from nose a		•	مه	ما	87-06			Y-H
26	ko		vith initial pitales' rotation	do	•		lo- Eq	nel to 2 per- cent of wing	to	40	14-2
27			Released from moss-as ;	do	٠	60		area -do	-40	to	V-8
1 1	Two personutes installed				•	40	اما	None	-40 3	etween elevons end pitch	
29				60	ه				A	flame t wing	VZIII
10	One parachute installed	do			•	ه- امه		40	30 В	tip etween elevons end pitch	viii
					\perp					flaps	_

MATICIAL ADVISORY CONSISTEM FOR AMPORAUTICS

Ì



TABLE III.- MASS CHARACTERISTICS AND INERTIA PARAMETERS FOR VARIOUS LOADINGS POSSIBLE
ON THE NORTHROP N-9M AIRPLANE AND FOR THE LOADINGS TESTED ON THE 1/20-SCALE MODELS
[Model values are presented in terms of full-scale values]

			μ Center-of-gravity location			Moments of inertia about center of gravity				
¥7.	Loading	(1b) Sea level		15,000 feet	X	<u>Z</u>	IX (slug-ft ²)	I _Y (slug-ft ²)	I _Z (slug-ft ²)	
		A	irplane	value	8				· · · · · · · · · · · · · · · · · · ·	
1	Flight test condition number 1	6,517	2.90	4.61	0.29	-0.04	19,045	2,288	21,099	
2	Flight test condition number 2	6,717	2.99	4.75	•27	Oh	19,058	2,574	21,373	
3	Flight test condition number 3	6,917	3.08	4.89	.25	04	19,051	2,879	21,684	
			Model	values						
1	Flight test condition number 1	6,526	2.91	4.62	0.29	-0.04	19,138	2,274	21,298	

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS



122000

TABLE IV. - TOUGLING CHARACTERISTICS OF THE 1/20-SCALE HODGES OF THE HORTEROF N-9K ADMITABLE

VERM LAURCHED VITE DETYLAL PURCHING ROTATION

[Tunnel airspeed for all tests was approximately 65 feet per second]

CONFIDENTIAL

Change from original, clean configuration	Lording	Pirection of initial pitching rotation	Stick position	Wheel position	Landing flaps	Pitch flame (deg)	Lending goar	Behavior of model
				inal model			-	
Hone	Flight test condition	Positive	Fell beck	Full left	Soutral	0	Retracted	Continued tumbling.
	number l		Full forward					Do.
30			Full back	Neutral	40			Sometimes continued tembling; sometimes
B0			,	1		1 1		stopped tumbling and oscillated in
	1 1	Į.		1	ł	1	l	pitch approximately \$120° measured
		. 1		l	ı	1	l .	from the none-down position until
	l i			l	ı	1	l	
			Merctare 1	do				Continued tradition
Do	do		Fell former	do		ŏ		Continued tumbling.
Do	do	do	Tull back	Full right	40	l ŏ		Do.
Do		Tegative	Fall back	Full left		ŏ		Do.
Do		40	Full Persond	do		łō		Do.
Do		do	Full back	Neutral				Sometimes continued tumbling; sometimes
10						'		stowed tumbling and oscillated in
•	1 !	1	1	I	ı	1	1	pitch approximately \$1200 measured
	1		l	ı	1		ı	from the nose-down position until
	1	· ·	i	ı	ı		I	striking safety not.
Do			Kentral	do		0	40	Continued tumbling.
Do			Full formati		20	0		} ⊅o.
700		40	Full beck	Full right		10	do	Sometimes continued tumbling; sometimes
24 10000000			i	-	1	1]	stopped tumbling and oscillated in
	1	1	i	1	1	1	l	witch approximately \$1200 measured
	1	ı	1	1	ŀ	!	1	from the nose-down position matil
	Į.	l l	l .	Į.	1	1	l	striking safety net.
		3. 2	ffsot af equive	lent propel	ler fin	ATTER	L	<u> </u>
	Land took continue		Full back	Full left		_	Retrected	Continued tumbling.
wivalent propeller	Flight test condition			1	1	1	_	-
fin area installed	HOMOST A		Pull Second			0		Do.
30	do		Fell best	Feutral		Ò	do	Do.
30			Jentrel.	do		10	đo	Do.
Do			Full Serveri	do		ه ا	40	Do.
90			Full bok	Full right		1 0		Do.
30		Begative		Full left		c		Do.
Do				do				Do.
Do			Full lek	Heutrel.		l c		Do.
Do								
			. Wouters	do	40	ے ا		I Bo.
Do	. {do		Fall femant	do	40	ے ا		Do. Do.
Do	do		Fall femant	do Full right	do	0		Do. Do. Do.
Do	do		Fell fever Fell lack	Full right	do	0 C		Do.
Do	do	do	Fall feari Fall hel	Full right	do do y locati	c c	do	Do. Do.
Do	Center-of-gravity 5 percent of forward of normal location for flight test condition	G. Positive	Fall fears Fall act Effect / carte	Full right	do do y locati	c c	do	Do.
Do	Center-of-gravity 5 percent of foresert of normal location for flight test condition number 1	G. Positive	Fall fears Fall act Effect / carte	Full right	dododo	C C C	Retrected	Do. Do.
Do	Center-of-gravity 5 percent of forward of normal location for flight test condition number 1	G. Positive	Full fearl Full ack Full ack Full ack	Full right	y locati	C C	Retrected	Do. Do. Continued tembling,
None	Center-of-gravity 5 percent of 1 corest or formal 1 continn for flight test condition number 1	C. Positive	Full fensel Full ack Full ack Full ack Full seck	Full left Full left Full left	y locati	C 000	Retracted	Do. Continued tembling.
None	Center-of-gravity 5 percent a foresent of normal location for flight test condition number 1	C. Positive	Full femant Fall inch Erfact / conte Full Eck	Full left Full left Full left Full deft do Seutral	y locati	C C C C C C C C C C C C C C C C C C C	Retrected	Do. Do. Continued tambling. Do. Do.
None	Center-of-gravity 5 percent of forward of normal location for flight test condition number 1	C. Positive	Full faces Full ack Full ack Full ack Full ack Full faces Full faces Full faces Full faces Full faces Full faces	Full left	y locati Heutral	C 00000	Retracted	Do. Do. Continued tembling. Do. Do. Do. Do. Do. Do.
Do	Center-of-gravity 5 percent of forward of normal loostion for flight test condition number 1 do- do-	C. Positive	Full faces Full ack Full ack Full ack Full ack Full ack Full ack Full faces Full faces Full faces	Full left Full left Full left Full deft do Seutral	y locati Heutral	C 00000	Retracted	Do.
None	Center-of-gravity 5 percent of foresert of normal location for flight test condition number 1	C. Positive	Full femal Full fack Full for the Full for t	Full left	y locati Heutral	C 00000	Retracted	Do.
Do	Center-of-gravity 5 percent of forward of normal location for filight test condition maker 1	C. Fositive	Full femal Full ack Full ack Full ack Full ack Full femal Full femal Full femal Full femal Full femal	Full left Full left Full left Full left Full left Full right	V locati	C 000000	Retracted	Do.
Do	Center-of-gravity 5 percent of forward of normal location for filight test condition maker 1	C. Fositive	Full femal Full ack Full ack Full ack Full ack Full femal Full femal Full femal Full femal Full femal	Full left	V locati	C 000000	Retracted	Do.
Do	Center-of-gravity 5 percent of forward of normal loostion for flight test condition number 1 do- do-	C. Fositive	Full femal Full ack Full ack Full ack Full ack Full femal Full femal Full femal Full femal Full femal	Full left Full left Full left Full left Full left Full right	V locati	C 000000	Retracted	Do.
Do	Center-of-gravity 5 percent of forward of normal location for filight test condition maker 1	C. Fositive	Full femal Full ack Full ack Full ack Full ack Full femal Full femal Full femal Full femal Full femal	Full left Full left Full left Full left Full left Full right	V locati	C 000000	Retracted	Do.
Do	Center-of-gravity 5 percent of forward of normal location for filight test condition maker 1	C. Fositive	Full femal Full ack Full ack Full ack Full ack Full femal Full femal Full femal Full femal Full femal	Full left Full left Full left Full left Full left Full right	V locati	C 000000	Retracted	Continued tembling. Do. Do. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent of foresent of sormal location for flight test condition master 1	C. Positive	Full femant Full fact Full fact Full for Full femant Full femant Full femant Full femant Full femant Full femant	Pall right r-of-gravit Pall left	V locati	c 000000 0	Retracted	Do.
Do	Center-of-gravity 5 percent of foresent of sormal location for flight test condition master 1	C. Positive	Full femant Full fact Full fact Full for Full femant Full femant Full femant Full femant Full femant Full femant	Full left Full left Full left Full left Full left Full right	V locati	c 000000 0	Retracted	Continued tembling. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent of forward of normal location for flight test condition maker 1	C. Positive	Full femant Full fact Full fact Full for Full femant Full femant Full femant Full femant Full femant Full femant	Pall right r-of-gravit Pall left	V locati	c 000000 0	Retracted	Continued tumbling. Do. Do. Do. Do. Do. Do. Do. Do. Stopped tumbling, made two oscillations in pitch of approximately \$120° measured from the nose-down position than oscillations started to dame on Sometimes continued tumbling; emetimately \$120° measured from the nose-down position then escillations started to dame on Stopped tumbling, made two oscillations in pitch of approximately \$120° measured from the nose-down position then escillations started to dame on Stopped tumbling, made two oscillations in pitch of approximately \$120°
Do	Center-of-gravity 5 percent of foresent of sormal location for flight test condition master 1	C. Positive	Full femant Full fact Full fact Full for Full femant Full femant Full femant Full femant Full femant Full femant	Pall right r-of-gravit Pall left	V locati	c 000000 0	Retracted	Continued tembling. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent a forward of sormal location for flight test condition number 1	C. Positive	Full former	do	y locati Heutral	C 0000000 0	Retrected	Do.
Do	Center-of-gravity 5 percent a forward of normal loastion for flight test condition master 1 do do do do do do do	C. Positive	Full forms Full for was	Full right rof-gravit Full left Full left Sutral Full left Full left Full left Full reft Full reft	y locati Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retracted	Continued tembling. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent of 1 corest of sormal 1 continn for flight test condition maker 1	C. Positive	Full former	do	y locati Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retracted	Do.
Do	Center-of-gravity 5 percent of 1 corest of sormal 1 continn for flight test condition maker 1	C. Positive	Full forms Full for was	Full right rof-gravit Full left Full left Sutral Full left Full left Full left Full reft Full reft	y locati Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retracted	Continued tembling. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent of 1 corest of sormal 1 continn for flight test condition maker 1	C. Positive	Full former	Full right rof-gravit Full left Full left Sutral Full left Full left Full left Full reft Full reft	y locati Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retracted	Do.
Do	Center-of-gravity 5 percent of 1 corest of sormal 1 continn for flight test condition maker 1	C. Positive	Full former	Full right rof-gravit Full left Full left Sutral Full left Full left Full left Full reft Full reft	y locati Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retracted	Continued tembling. Do. Do. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent of foresent of sormal location for flight test condition maker 1	C. Positive	Full forms Full ack Full ack Full ack Full forms	Full right rof-gravit Full left	y locati Feutral Feutral Feutral Feutral Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retrected	Do.
Do	Center-of-gravity 5 percent of foresent of sormal location for flight test condition maker 1	C. Positive	Full forms Full ack Full ack Full ack Full forms	Full right rof-gravit Full left	y locati Feutral Feutral Feutral Feutral Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retrected	Continued tembling. Do. Do. Do. Do. Do. Do. Do. D
Do	Center-of-gravity 5 percent of 1 corest of sormal 1 continn for flight test condition maker 1	C. Positive	Full forms Full ack Full ack Full ack Full forms	Full right rof-gravit Full left	y locati Feutral Feutral Feutral Feutral Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retrected	Do.
Do	Center-of-gravity 5 percent of foresent of sormal location for flight test condition maker 1	C. Positive	Full forms Full ack Full ack Full ack Full forms	Full right rof-gravit Full left	y locati Feutral Feutral Feutral Feutral Feutral Feutral	C C C C C C C C C C C C C C C C C C C	Retrected	Continued tembling. Do. Do. Do. Do. Do. Do. Do. D

MATICMAL ADVISORY CONSTITUTE FOR AMROMANTICS





NACA RM No. L6L10

THREE TY.- TERRITOR CREMACTERISTICS OF THE 1/20-SCALE MODELS OF THE RESTRICT N-98 AIRPLANE - Continued

Chemes from continued linking published publis				The state of the s											
C-second span, maker 1 maker 1 maker 2 maker 2 maker 3 maker 3 maker 4	original, clean	Losding	pitching	Stick position			flape	T-MARITIME.	Behavior of model						
member 1 sign state grants and the property of															
Do-	edge elete	Flight test condition number 1	Positive	Full back	Poll left	Foutral	٥	Retracted	Continued tunbling.						
Both Search Continued twanking. Do	Do					đo			stopped tumbling, made two oscillation in pitch of approximately \$1200 measure from the nose-down position, them oscillations standard to down onto						
Do	Do		%	LAIT post			0	40	Continued trabling.						
Do	Do			Maria Committee		do		60	Do.						
De de Bagative Pail formet Poil bag Poi	Do				Tull whete	40	2		Do.						
Do do Begative Pail fewer do	D0			Pell forward											
Do do do Pall Named Polished P	Donner		Megative	Pull lesk	rell left										
Do do do Pillack Several do 0 do Stopped tambling, made use continutous in gittle the same-dom portion, and the same do do several problems and the same dome portion, and the same dome portion are portion, and the same dome portion are portion and the same dome portion are started to any ort, then dived. Do dome dome d				Fall franci			0	do	Do.						
Do do do Pull have provided to do continued tambling to c	Do			Pull back	Bewtral.	t o	٥	60	Stopped tumbling, made two oscillations in pitch of approximately +120° measured from the mose-down mostifes.						
Do do do Pull New Pull New Pull Park Do	_	I .	l		a		ا 🔒 ا		then oscillations started to dame out						
Do				Tull better				40	Continued tumbling.						
Positive for prevent symmatric properties of the properties of t				Full Mok	Tall right										
Particular Properties Particular Par				Fall forward		60			70.						
Prince types, serilistic problems and the prince of the pr			·												
smilitary Leading- edge slate installed Do		1													
Do do Full act of	auxiliary leading- edge slate		Positive	, m	Juli lete	Beutral	Ů	He taracted	Continued tembling.						
Do do do Full wat from the provided by the first position, contilutions started to damp out, then dived. Do do do do Full wat from the most-down position, contilutions in gitch of approximately also measured from the most-down position, contilutions in gitch of approximately also measured from the most-down position, contilutions in gitch of approximately also measured to despect the first position of the first po				Pull brend		·do	0	to	uscillations in pitch of approximately						
Palling Pall	Do		do	Pall has	Routrel	40			position, oscillations started to damp out, then dived. Continued tumbling.						
Palling Pall	Do			Heuby_			• I	601	Do.						
Do	Do								stopped tumbling, made one or two decillations in witch of approximately \$1200 measured from the mose-down position, oscillations started to						
Do				PullPlack	क्षा मध्यक्ष	40	0		Continued tumbling,						
Do	Do	-}					2 1		Do.						
Do	00		12924140		7411 1814				1120° measured from the nose-down						
Do	Do			Followed	do	40	°		Sometimes continued tumbling; scentimes stopped tumbling, made one or two decillations in pitch of approximately \$120° measured from the nose-down weathing, oscillations started to						
Pull right and one or two oscillations in pitch of sprortimates the nose-down position, oscillations in pitch of sprortimates the pose-down position, oscillations started to damp out, then dived. Tell found and one or two oscillations will pitch of sprortimates the position oscillations in pitch of sprortimates.	Do			Fulleck	Boutral	40		- 1	41300 measured from the none-down						
Pull right and one or two oscillations in pitch of sprortimates the nose-down position, oscillations in pitch of sprortimates the pose-down position, oscillations started to damp out, then dived. Tell found and one or two oscillations will pitch of sprortimates the position oscillations in pitch of sprortimates.	Do	ac		- How				00	Continued tumbling.						
Do	Do			- Pullment				مه	Do.						
stoppes tumbing, make case or two cacillations in pitch of approximatel til00 measured from the nose-down position, oscillations started to				Permit					decillations in pitch of approximately 1200 measured from the nose-down position, oscillations started to damp out, then dived.						
	Do			The state of	\				stopped tumbling, made one or two oscillations in pitch of approximatel; tl200 measured from the nose-down position, oscillations started to						

MATTOWAL ADVISORY CONSCITURE FOR ARROBAUTICS



TABLE IV.- TORRIDE CHARACTERISTICS OF THE 1/20-SCALE MINELS OF THE MORTHUS N-9K ADVILORS - Concluded

*		Direction of						
Change from original, alean comfiguration	Lording	initial pitching rotation	Stick position	Vheel position	Landing flaps	fitch flage (deg)	Landing goar	Schavior of model
			F. Effects	of split ro	iders			
73-35 type split redders installed and deflected 460°	Flight test condition, master 1	Positive	Full back	Full left	Bentral	٥	Retracted	Continued tumbling.
on both wing tipe		do	Full forward Full beck	do	do	°	do	Do.
Do			Houtrel.		40	1 0	40	Po. Po.
Do			Full ferward	do	t o		40	Do,
Do			Pull back	Full right	60	8	do	, 10,
Do		Hegative	Fall ferrird		40		do	De.
30			Pull back	Moutrel		ŏ		Do.
Do		40	Icuite1		do	0		Do.
Do			Fell forward Fell back	Full right	40	8	i o	Do. Do.
						_		100.
			3. Effect of b		_	_		
Landing	Flight test condition member 1		1	í	1	1 7	Extended	Continued tumbling.
D0			Seutral	Neutral				Do.
Do	do		Full forward		do		40	Do.
Do			MATT MOOK	Full right			40	De. Do.
Do	40	Megative	Pall back	Full left	40	o		Do.
Do				Boutrel	40	0		Do.
Do		40			do	:		Do. Do.
Do		l 	Full back	Full right	do	اۃا) 5°.
Do			Pell forward	do		ا ۃ ا		Do.
	I. Effect	of installi	ng horizoni	rea equal to	o 10 perc	est of	the ving	area
		Positive	Toll back	Poll left	Yentral.	٦	Retrected.	Stopped tembling, oscillations in
Horizontal area equal to 10 percent of the wing area installed on a	Flight test condition mamber 1	POSITIVE	,	7422 22.0				witch damped out rapidly, them dived
boom rearward of		}]			[
the model			Full Coronal	00	40	0	to	Do.
Do	· [do	Full beat	Heutrel		1 0 1		Do.
Do			Fell formed	raa	60		40	De. De.
Do			Full less	Pall what				De.
Do	40		Full perwari		&	ΙōΙ		Do.
Do		Meastive	Full Beek	Fell left			œ	Do.
Do								Do. Do.
Do					do			Do.
Do			- Hestral			8	10	Do. Do.
Do	do		Fall Second	do	40	0 0		Do.
Do	do		Full Squark Full Squark Full Squark	Full right		0 0 0 0		Do. Do. Do. Do.
Do Do	I. Effe	do d	Heatral Full Second Full Second Full Second	Full right		o o o o	the wing	Do. Do. Do. Do.
Borizontal area equal to 5 percent of the vine area installa	I. Effi	do d	Full Second Full Second Full Second	Full right		o o o o	the wing	Do. Do. Do. Do. Do. Stores trushling, oscillations in
Borizontal area equal to 5 percent of the wing area installs on a boom rearrant	I. Effi	ot of instal	Full Second Full Second Full Second Full Second Full Second Full Second	Full right	to 5 percent	o o	dodododo	Do. Do. Do. Do. Storped tumbling, cecillations in gitch damped out rapidly, them dived
Bortsontal area equal to 5 percent of the wing area installar on a boom reareard of the model.	I. Err	ot of instal	Full beauth	Full right	doto 5 perc	emat of	the wing	Do. Do. Do. Do. Stopped tumbling, oscillations in gitch damped out rapidly, them dived
Borttontal area equal to 5 percent of the model	T. Erro	oct of instal	Full forunt	Full right rea equal Full left do Beutral	to 5 perc	0 0 0 0	the wing	Do. Do. Do. Do. Storped tumbling, cecillations in gitch damped out rapidly, them dived
Borttontal area equal to 5 percent of the model Do Do Bortsontal area equal to 5 percent of the model Do Do	Flight test condition number 1	ot of instal	Full beauty Full	Full rightdo rea equal Full leftdo	to 5 perc	0 0 0 0 0 0	the wing	Do. Do. Do. Do. Stopped tumbling, cecillations in gitch damped out rapidly, them dived Do. Do. Do. Do.
Borttontal area equal to 7 percent of the ving area installed on a boos research of the model.	I. Erri	roative	Full heart	Full rightdo rea equal rull leftdo Reutraldo Full right	Heutrel	0 0 0 0 0 0		Do. Do. Do. Do. Do. Stopped tumbling, oscillations in sitch damped out rapidly, them diversity them be. Do. Do. Do. Do. Do. Do. Do. Do. Do.
Bortcortal area equal to 9 percent of the model to Do	Flight test condition pusher 1 de	ot of instal	Full farmed	rea equal Full left do Beutraldo Full left Full left	to 5 percent leave to 1 percent	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	the wing	Do. Do. Do. Do. Stopped tumbling, cecillations in gitch damped out rapidly, them dived Do. Do. Do. Do. Do. Do. Do. Do. Do.
Borttontal area equal to 2 percent of the wing area installs on a book rearear of the model. Do	I. Erri	ot of instal	Full format	rull rightdo Full rightdo Reutraldo Full right Full left	to 5 percent	0 0 0 0 0 0 0 0 0 0 0		Do. Do. Do. Do. Do. Stopped tumbling, oscillations in sitch damped out rapidly, them diversity them be. Do. Do. Do. Do. Do. Do. Do. Do. Do.
Bortcortal area equal to 9 percent of the model to Do	Flight test condition Flight test condition Fligh	ot of install Positive	Full format	rea equal rull left do Ecutruldododododododododododododo	Beutral	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	the wing	Do. Do. Do. Do. Do. area Stopped tumbling, oscillations in sitch damped out rapidly, then diversity the damped out rapidly. The diversity the damped out rapidly are diversity to the damped out rapidly. The damped out rapidly then diversity the damped out rapidly the damped out rapidly the damped out rapidly then diversity the damped out rapidly the damped out rapi
Bortcortal area equal to 9 percent of the mass about rearward of the model Do	Flight test condition T. Effect Flight test condition Description A	Positive	Sustail Sustail Sustail Pull Susual	rull rightdo Full rightdo Reutraldo Full right Full left	Teutral	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Do. Do. Do. Do. area Stopped tumbling, oscillations in pitch damped out rapidly, them diversely be. Do. Do. Do. Do. Do. Do. Do. Do. Do. Do
Bortsontal area equal to 5 percent of the ving area installs on a boon reareard of the model. Bo	Flight test condition T. Eff. Plight test condition Description Address of test condition Description D	Fortive	Mattal Full Security	rea equal right and a common c	Beutral	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Do. Do. Do. Do. Do. Do. Stopped tumbling, cecillations in pitch damped out rapidly, them dived Do.
Borttontal area equal to 9 percent of the wing area installed on a book reason of the Borttontal Bo	Flight test condition T. Eff. Plight test condition Description Address of test condition Description D	Fortive	Full format Full	rea equal right and a common c	Beutral	ent of		Do. Do. Do. Do. Do. Do. Area Stopped tumbling, oscillations in pitch damped out rapidly, then dived to the pitch damped out bo. Do. Do. Do. Do. Do. Do. Do. Do. Do. D
Boritontal area equal to 5 percent of the wing area installed on a boom rearward of the model. Do	Flight test condition maker 1 for the second test of the second test	so do	Full format Full	rea equal right and a common c	Teutral Teutral Teutral Teutral Teutral Teutral Teutral Teutral Teutral	o o o o o o o o o o o o o o o o o o o		Do. Do. Do. Do. Do. Do. Stopped tumbling, cecillations in pitch damped out rapidly, them dived Do.
Borttontal area equal to 7 percent of the wing area installed in a book reareast of the model bo- Bo- Bo- Bo- Bo- Bo- Bo- Bo-	Flight test condition Tight test condition	so do	Full format Full	real right real equal rull left Beutral	Teutral Teutral Teutral Teutral Teutral Teutral Teutral Teutral Teutral	o o o o o o o o o o o o o o o o o o o		Do. Do. Do. Do. Do. area Stopped tumbling, oscillations in pitch damped out rapidly, then diversely be. Do. Do. Do. Do. Do. Do. Do. Do. Do. Do
Borizontal area equal to 5 percent of the wing area install con a book rearward of the model bo	Flight test condition maker 1 Flight test condition do do do do do do do do do	Foritive	Full format Full	rea equal trust rea equal trust reserved trust rese	Tentral	o o o o o o o o o o o o o o o o o o o	- do	Do. Do. Do. Do. Do. area Stopped tumbling, cecillations in gitch damped out rapidly, them diversely be
Bortsontal area equal to 9 percent of the wing area installs on a boon rearward of the model Do	Flight test condition T. Effect Flight test condition and test condition and test condition and test condition and test condition J. Effect marker 1 flight test condition marker 1	Fositive	Full format Full	real right real equal rull left Rettral	Teutral	o o o o o o o o o o o o o o o o o o o		Do. Do. Do. Do. Do. Stopped tumbling, oscillations in pitch damped out rapidly, them diversely be
Borttontal area equal to 9 percent of the work of the model to 2 percent of the source	Flight test condition T. Effect Flight test condition and test condition and test condition and test condition and test condition J. Effect marker 1 flight test condition marker 1	Fositive	Full format Full	rea equal trust rea equal trust reserved trust rese	Tentral	o o o o o o o o o o o o o o o o o o o		Do.
Bortsontal area equal to 9 percent of the wing area installs on a boon rearward of the model Do	Flight test condition T. Eff Flight test condition do do do do do do do do do	so s	Full format Full format Full format Full back Full back Full back Full back Full format Full back Full format Full back Full format Full back Full format Full back Full format Full format Full back Full format Full format Full back Full format Full format Full back Full back Full back Full back Full format Full back Full back	real right real equal real left real left real left real left real left real left real right real right real right real left real left real left real left real left real left real right real right real right real right real right	medo	emut of		Do.
Bortsontal area equal to 9 percent of the wing area installs on a boos reservant of the model Do	Flight test condition I. Eff Flight test condition do do do do do do do do do	store do	Full format Full format Full format Full bed Full format Full for	rea equal real right rea equal rull left Reutral	Beutral	and of o	the wing	Do.
Bortsontal area equal to 9 percent of the wing area installs on a boon rearward of the model Do	Flight test condition about the second of t	do d	Full formal	real right real equal rull left real left real left real left real left real left real right real rea	medo	emut of	the wing	Do.
Bortsontal area equal to 9 percent of the wing area installs on a boon rearward of the model Do	Flight test condition masker l T. Effect pumber l do do do do do do do do do d	so do	Full formal	rea equal real right rea equal rull left Reutral	Beutral	and of o		Do.
Borttontal area equal to 9 percent of the wing area installed in a boar reareard of the model. Borttontal area equal to 10 percent of the model. Borttontal area equal to 2 percent of the model. Borttontal area equal to 2 percent of the model. Dobortontal area equal to 2 percent of the model. Dobortontal area equal to 2 percent of the model. Dobortontal area equal to 2 percent of the model. Dobortontal area equal to 2 percent of the model. Dobortontal area equal to 2 percent of the model.	Flight test condition masker l T. Effect pumber l do do do do do do do do do d	so do	Full format Full	rea equal real right	Beutral	sart of	the wing	Do.
Borizontal area equal to 9 percent of the wing area installed a a boom rearward of the model Do	Flight test condition and the second transfer is a second transfer in the second transfer in the second transfer is a second transfer in the	store do	Full format Full	real right	Beutral dododododododo	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Do.
Boritontal area equal to 9 percent of the ving area installed on a boon rearward of the note. Boritontal area equal to 1000 Boritontal area equal to 1000 Boritontal area equal to 2 percent of the ving area install on a boon rearward of the model. Boritontal area equal to 2 percent of the model on a boon rearward of the model on boritontal area installed to 1000 Boritontal area equal	Flight test condition masker l T. Effect pumber l do do do do do do do do do d	So-do-do-do-do-do-do-do-do-do-do-do-do-do	Full format Full bed Full format Full bed Full bed Full format Full bed Fu	rea equal real right	Tentral	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	the wing Tetracted The wing Tetracted The wing Tetracted The wing Tetracted	Do.

HATTOWAL ADVISORY CONNETTED FOR ARCHAUTES





TABLE V.- TURBLING CHARACTERISTICS OF THE 1/20-SCALE MODELS OF THE NORTHEOF H-OM AIRPLANE WHEN RELEASED VITEOUT ROTATION FROM A MOSE-UP VERTICAL AFTERUDE

[Tunnel airspeed for all tests was approximately 75 feet per second full scale]

			=				
Change from original, clean configuration	Losding	Stick position	Wheel position	Landing flaps	Pitch flaps (deg)	Landing goar	Behavior of model
		A. 0	riginal mode	1			
Rone	Flight test condition	Full back	Full left		o	Retracted	Sometimes tumbled; sometimes oscillated in pitch approxi- mately 1120° measured from the nose-down position until striking safety met.
Do	do	Full forward	do	40		~do	Do.
Bo		Full back Neutral	Heutrell	do	0	do	
Do	do	Trill formers			0	10	Do.
Do	do	Full beck	rall right		ŏ		Do. Do.
	В.	Effect of equi	valent prop	eller fir	area		
Equivalent propeller	Flight test condition	Full forward	Full left	Neutral	0	Retracted	Oscillated in pitch approxi-
fin area installed	musher 1	į	Neutral				mately ti200 measured from the nose-down position until striking safety met. Sometimes tumbled; sometimes oscillated in pitch approxi- mately ti200 measured from the nose-down position until striking safety met.
Pa]	Mantrel /		do	اه	do	Do.
Do		Full formet	do	80		ão	Do.
Do	do	Full back	Full right	do	0	do	Do.
	C	. Riffect of co	par-of-grav	ity locat	1on		
None	Center of gravity 5 percent c forward of normal location for flight test condi- tion number l	Full back	111 10ft	Neutral	٥	Retracted	Made two oscillations in witch of approximately ti20° measured from the nose-down position, then contillations started to damp out.
D0	- do	Full forest	do	ao		40	Do.
Do	. do	Pull back \	Deptral	00[do	Do.
Do	do	Wenter's		ào		40	Do.
Do	do	full formal		do	0	do	Do. Do.
Do	do	Tull forward	TILL LIGHT	do		do	Do.
		D. Effect of		<u> </u>		ــــــــــــــــــــــــــــــــــــــ	
20-percent span	Flight test condition	Foll 🖛 (Full left	Neutral	0	etracted	Made two oscillations in pitch of approximately 11200 measured
auxiliary leading- edge slat: installed	number 1					_	from the none-down position, then oscillations started to damp out.
						do	Do.
	do	}	•				Sometimes tumbled; sometimes made two oscillations in pitch of approximately ±120° measured fro the nose-down position, then cacillations started to damp out
Do						do	Do.
	do		do	do	0 -	do [Made two oscillations in pitch of approximately \$120° measured from the nose-down position, then oscillations started to damp out.
	1	1 . 1					
Da	do	PLI have 1	Full right!	do [0 1-		Do.
Do		FI formal	Full right	do		do	Do.

NATIONAL ADVISORY COMMITTEE FOR AEROHAUTICS





NACA RM No. L6L10

TABLE V .- TUMBLING CHARACTERISTICS OF THE 1/20-SCALE MODELS OF THE MURTHOOP M-9M AIRPLANE - Continued

				•								
Change from original, clean configuration	Loading	Stick position	Wheel position	Lendi	P1: 11: (4:	I Tandite	g Behavior of model					
E. Effect of 33-percent spen alots												
35-percent span auxiliary leading- edge slats installed	Flight test condition number 1	Full back	Full left			Retracte	d Made one or two oscillations in pitch of approximately #1200 measured from the nose-down position, oscilla-					
Do	do	Full forward Full back	do		0	do	Do. Sometimes tumbled; sometimes made one or two oscillations in pitch of approximately #1000 measured from					
	do	Neutral Full forward	do	do			started to damy out, them dived. Made one or two oscillations in pitch of approximately #1200 measured from the nose-four position, oscillations started to damp out then dived.					
Do	do	Full back	no right			do	20.					
Do	10	Full former			١ŏ	do	Do. Do.					
	l	<u> </u>		1 -			10.					
		y. Effet	of split r	widers		_						
IB-35 type split ruiders installed and deflected 160° on both wing tips	Flight test condition number 1	Full back	Mil left		٥	Retracted	Oscillated in pitch approximately tl20° measured from the nose-down position until striking safety nat.					
Ъо	do	Full forward	f-10	do	0	do	Do.					
Do	do	Full back	Mutral	do	10	do	Do.					
		Neutral	do		°		Sometimes tumbled; scmetimes oscillated in pitch approximately \$1200 measured from the nose-down position until striking safety net					
	•	Full forward		do	°		Oscillated in pitch approximately ±120° neasured from the nese-down position until striking safety net.					
Do	10	Full back	right	'do	°	do	Scentimes tumbled; sometimes oscillated in pitch approximately 1120° measured from the nose-down position until striking safety net.					
Do	do	Neutral	do	do	٥	to	Oscillated in pitch approximately ±1200 measured from the nose-down position until striking safety net.					
Do	do	Full forward	do	đo	٥	do	Do.					
		G. Effect of	pling cor	figurati	œ							
Landing	Flight test condition	Full back	Tart left	50° down	26 m	Extended	Made one or two oscillations in pitch					
	number l		/				of approximately f120° measured from the nose-down position, oscillations started to damp out, then dived.					
Do	do	Initior and	do	do	0	do	Do.					
Do	do	Ful beak	Metral	do	0	do	Do. Do.					
**		Full forward	dol	do	ŏ	do	Do.					
Do	do	THE DEED	Ful right	40	ŏ	do	Do.					
Do	do	Full forware	-to	do	0	do	Do.					
		ffect of lands	S Flams and	landing	#BAT							
		Full beck		50° down		Extended	W-1					
Lending flaps deflected and landing gear extended	Flight test condition number 1				°	Artended	Made one or two oscillations in pitch of approximately 1120° measured from the nose-icum position, oscillations started to damp out, then dived.					
•	do	Heutral -	10		ا ہ	10	then dived.					
Da	do	Full forth i	20	do	ŏ	do	Do.					
Do	do	Full bed /	ull right	do	0	do	Do.					
~												

NATIONAL ADVISORY CONNITTEE FOR AERONAUTICS





TABLE V.- TURNLING CHARACTERISTICS OF THE 1/20-SCALE MODELS OR THE SUPTEMOP H-9M AIRPLANE - Concluded

Change from original, clean configuration	Loading	Stick position	Wheel position	Landing flaps	Pitch flape (de-)	Landing	Behavior of model
		I. Effect	of landing	flaps			
Lending flaps deflected	Flight test condition number 1	Full back	Full left	50° done	٥	Retracted	Made one or two oscillations in pitch of approximately 11200 measured from the nose-down position,
Pa	do	Full forward	do	40	۰	do	oscillations started to day out, then dived.
Do	do	Full back	Teutral	do	ŏ		Do.
Do	à	Neutrel	Jdo		0	do	Do.
Do		Full forward Full back	Fall right		8	do	Do. Do.
		J. Effect	of landing	gear	Щ_		
Pitch flaps	Flight test condition	Full back	Neutral	Hentrel	0	Primied	Scmetimes tumbled; scmetimes oscillated
extended	number 1		}				in pitch approximately 1200 measured from the ness-down position until striking safety net.
Do	do	Neutral Full forward	to		0		Do.
Do		Full Tortal			ٿ		Do.
		K. Effect	of pitch	flape			
Pitch flaps deflected	Flight test condition number 1	Full beak	Man Jete	Soutral	26 mg	Retracted	Sometimes tumbled; semetimes oscillated in pitch approximately 1200 measured from the nose-down position until
Do	do	Full forward	do		d o-	to	striking safety net. Oscillated in pitch approximately il200 massured from the nose-down position
Do	do	Full back	Neutral	đo	do-	do	until striking safety net. Sometimes tumbled; sometimes oscillated in pitch approximately 1220 measured
Do	do	Houtral		do	40-	do	from the name-town position until striking safety net. Do.
Do	do	Full forward	Bull right	do	60-	do	De. De.
	L. Effect of inst	alling horizont	L area equ	1 to 10	perce	nt of the	Fing area
			PAL left				Made one or two oscillations in
Horizontal area equal to 10 percent of the wing area installed on a boom	number 1		}			2007	pitch and then dived.
rearward of the	7]	1	1	!			
	1		ı				
			Soutral		0	åo	Do.
		Toutral		00	0		Do.
nodel. Do Do		Heutral Full forward Full beek		do	0		
nodel. Do Do		Tun desi	Pall right	do do	000	do	Do. Do. Do.
nodel. Do Do	M. Effect of instal	ling borizonta	Full right	do do to 5 per	o o cent	do do of the wing	Do. Do. Do.
Borizontal area equal to 5 percent of the wing area installed	N. Effect of instal	ling borizonta	Pall right	do do to 5 per	o o cent	do do	Do. Do.
Borizontal area equal to 5 percent of the wing area installed on a boost reservent of the model.	N. Effect of instal	ling horizonta	Fel left	do do to 5 per	cent	do of the wing	Do. Do. Do. g area Hade one or two oscillations in pitch, and then dived.
Borizontal area equal to 5 percent of the wing area installed on a book rearward of the model	N. Effect of instal	ling horizonta	Fil right	to 5 per	cent	do of the wing	Do. Do. Do. 3 area Hade one or two oscillations in pitch, and then dived. Do.
Borizontal area equal to 5 percent of the wing area installed on a boost rearward of the model.	N. Effect of instal	Ing horizonta Pull back Full formed Full had	Fil right my equal Fil lort mutral	to 5 per	cent c	retracted	Do. Do. Do. s area Hade one or two cecillations in pitch, and then dived.
Borizontal area equal to 5 percent of the wing area installed on a book rearward of the model	N. Effect of instal	ling horizonta Full back Full formed Full back	Fil right	to 5 per	cent	Retracted	Do. Do. Do. S area Hads one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do.
Bornsontal area equal to 5 percent of the wing area installed on a boos rearward of the model Do	N. Effect of instal	Ing horizonta Full back Full formed Full back Full formed Full back	Fil right Tag equal Fil left Fil left Fourtral	to 5 per	cent c	Retracted	Do. Do. Do. 3 area Hads one or two oscillations in pitch, and then dived. Do. Do. Do.
Bo	N. Effect of instal	Ing horizonts Full back Full back Full back Full forward Full forward Full forward Full forward Full forward	Fel left do Fel right do Feutraldo Feutraldo Feutraldo Feutraldo Feutral	do to 5 per Heutral	cent c	Retracted	Do. Do. Do. S area Hads one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Do.
Borizontal area equal to 5 percent of the wing area installed on a boost rearward of the model. Do	N. Effect of instal Flight test condition masher 1	Ing horizonts Full back Full back Full back Full back Full back Full back Illing horizonts	Jest left Jest left	do to 5 per Heutral	cont c	Retracted	Do. Do. Do. 3 area Hads one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Do.
Bortsontal area equal to 5 percent of the wing area installed on a boos rearward of the model Do	N. Effect of instal	Ing horizonts Full back Full back Full back Full back Full back Full back Illing horizonts	Jest left Jest left	do	c c c c c c c c c c c c c c c c c c c	Retracted	Do. Do. Do. Do. S area Made one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Re area Kade one or two cecillations in
Borizontal area equal to 5 percent of the wing area installed on a boos rearward of the model Borizontal area equal to 2 percent of the wing area installed on a boos rearward of the model to 2 percent of the wing area installed on a boos rearward of the model.	N. Effect of instal	Full back	Fil right Fil left	do	c c c c c c c c c c c c c c c c c c c	Retracted	Do. Do. Do. Do. S area Hads one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Do. Do. Do. D
Boolel Bo Borizontal area equal to 5 percent of the wing area installed on a boos rearward of the model Bo	N. Effect of instal Flight test condition masher 1 dodododo	Full back Full back Full back Full back Full forward Full back Ling horizons Full back	Fil right Fil right Fil left Fil left Fourtel -do pull right area equal full left Neutral	dododododododod	cont c	Retracted dododododododododododo	Do. Do. Do. S area Made one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Do. Do. Do. D
Borizontal area equal to 5 percent of the wing area installed on a boos rearward of the model to 2 percent of the wing area installed on a boos rearward of the model to 2 percent of the wing area installed on a boos rearward of the model to 2 percent of 2 percent o	N. Effect of instal Flight test condition masher 1	Full back	Fil right Fil left Fil left Fil left Fourtral do pall right area equal Nutral do Nutral do do do	dododododododod	C C C C C C C C C C C C C C C C C C C	Retracted dododododododododododo	Do. Do. Do. Do. Do. S area Made one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Do. Do. Do. D
Borizontal area equal to 5 percent of the model Do	N. Effect of instal Flight test condition masher 1 dodododo	Full back Full back Full back Full back Full back Full back I forward Full back Full back Full back Full back Full back Full back Full back	Fil right Fil right Fil left Fil left Fourtel -do pull right area equal full left Neutral	dododododododod	cont c	Retracted dododododododododododo	Do. Do. Do. S area Made one or two oscillations in pitch, and then dived. Do. Do. Do. Do. Do. Do. Do. Do. Do. D

NATIONAL ADVISORY COMMITTEE FOR AEROKAUTICS



TABLE VI.- TUMBLING CHARACTERISTICS OF THE 1/20-SCALE MODELS OF THE NORTHROP N-9M AIRPLANE

WHEN RELEASED WITHOUT ROTATION FROM A HORIZONTAL ATTITUDE AND FROM A MOSE-DOWN ATTITUDE

Tunnel airspeed for all tests was approximately 75 feet per second

Change from original, clean	Loading	Stick	Wheel	Landing	Pitch flaps	Lending	Behavior of model
configuration		position	position	flaps	(geb)	gear	
	A. Nose	of model app	roximately 7	Oo below	horizor	ital when re	leased
None	Flight test	Full back	Full left	Neutral	O	Retracted	Dived with oscillations in
	condition					ì	pitch of approximately ±15
Do	do	Full forward	ao	do	0	đo	Do.
Do	do	Full forward	Neut yel	đo	0	do	Do.
Do	do	Neutral	qo	do	0	do	Do.
Do	go	Full forward Full back		do	0	go	Do.
20		FULL DACK	Full right	đo	0	do	Do.
		B. Mod	lel horizont	al when r	eleased		
None	Flight test	Full back	Full left	Neutral	0	Retracted	Made one or two oscillations
	condition		I				in pitch of approximately
	number 1						t400 then dived with
							oscillations rapidly
							diminishing in
Do	do	Full forward		_	_	_	emplitude.
Do	do	Full back	do	do	0	go	Do.
	do	Neutral	Noutral	do	0	đo	Do.
		Full forward		do	0	do	Do.
	do	Full back	Full right	~~]	0	do	Do.
			AMET LIBIT		٧	00	Do.

NATIONAL ADVISORY
CONSTITUE FOR AERONAUTICS



TABLE VII.- TUMBLING CHARACTERISTICS OF THE 1/20-SCALE MODELS OF THE

NORTHPOP K-9M AIRPLANE WIEST IMPELLED INTO TUNNEL WITH

NOSE SLIGHTLY ABOVE THE HORIZONTAL

Tunnel airspeed for all tests was approximately 75 feet per second

Change from original, clean configuration	Loading	Stick position	Wheel position	Landing	Pitch flaps (deg)	Landing	Behavior of model
Do Do Do	do	Full fo ward Full back Neutral Full forward	do Neutral do	do	0 00000	Retracted	Made one or two oscillation in pitch of approximatel t60° then dived with oscillations rapidly diminishing in amplitude. Do. Do. Do. Do. Do.

NATIONAL ADVISORY
COMMITTEE FOR AEROHAUTICS



TABLE VIII .- EFFECTIVENESS OF PARACHULES IN PRODUCING RECOVERY FROM ESTABLISHED

TUMBLES OF THE 1/20-SCALE MODELS OF THE NORTHROP N-9M ATRPLANE

Clean configuration; flight test condition number 1; stick neutral; wheel neutral; pitch flaps neutral; landing gear retracted; towline length as indicated; point of towline attachment as indicated; diameter of parachutes, 7 feet full scale; drag coefficient of parachutes, approximately 0.7; tunnel airspeed for all tests was approximately 5 feet per second full scale; models launched with initial positive pitching rotation; recoveries from tumbles attempted by opening parachutes as indicated

Towline attached to	Towline length (full scale) (ft)	Recovery attempted by	Tumbles for recovery after parachutes opened	Remarks
Fixed portion of wing between elevon and pitch flap	2.5	Opening 2 parachutes, one attached to each wing	>3, >3	Towlines and parachutes wrapped around wing, model continued tumbling.
Do	30 . 0	do	>3, >3	· Do.
Rear portion of wing tip	10.0	do	1½, 1½	After recovery from the tumble, model oscillated in pitch approximately ±90° measured from the nose-down position until striking the safety net.
Do	30.0	do	1, 1	Do.
Do	10.0	Opening parachute attached to right wing tip	1, 1 1, 2, 2,	Do.
Do	30.0	do	>2, >3	Model continued tumbling.

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

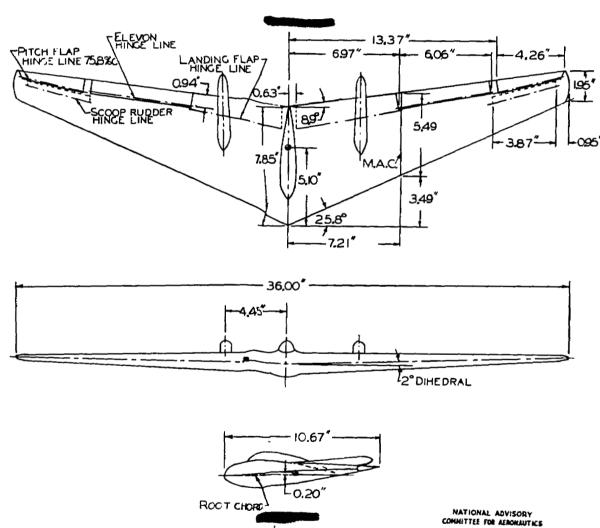


FIGURE 1.- THREE-VIEW DRAWING OF THE 3-SCALE MODEL OF THE NORTHROP N-9M AIRPLANE AS TESTED IN THE 20FOOT FREE-SPINNING TUNNEL, CENTER OF GRAVITY SHOWN FOR FLIGHT TEST CONDITION NUMBER 1.





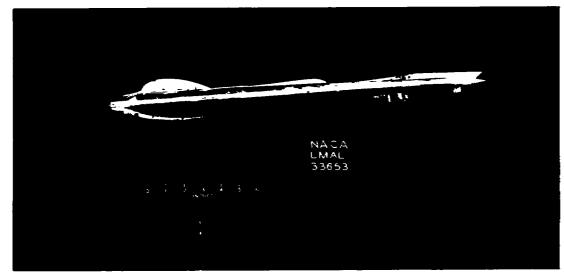




Figure 2.- A $\frac{1}{20}$ -scale model of the Northrop N-9M airplane as tested in the 20-foot free-spinning tunnel in the clean configuration.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS LANGLEY MEMORIAL AERONAUTICAL LABORATORY - LANGLEY FIELD. VA.





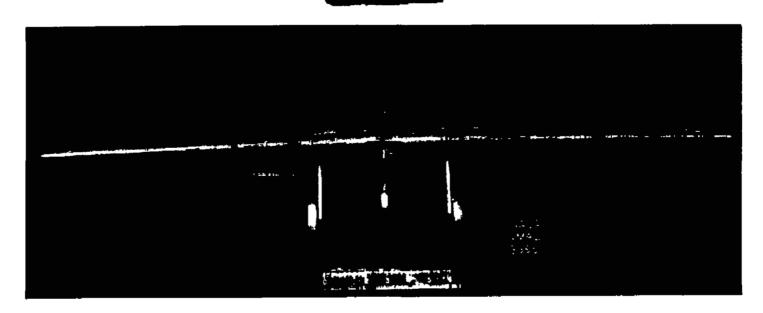


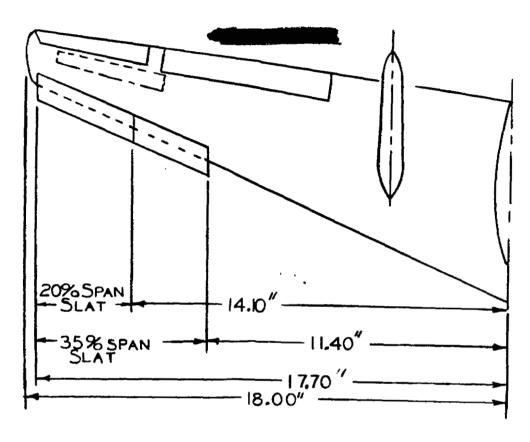
Figure 3.- A $\frac{1}{20}$ -scale model of the Northrop N-9M airplane as tested in the 20-foot free-spinning tunnel in the landing configuration.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

LANGLEY MEMORIAL AERONAUTICAL LABORATORY - LANGLEY FIELD VA.







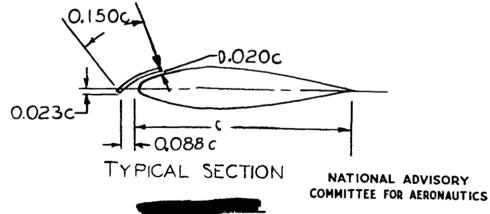


FIGURE 4.-SIMULATED SLATS TESTED ON THE \$\frac{1}{20}\cdot SCALE MODEL OF THE NORTHROP N-9M AIRPLANE,



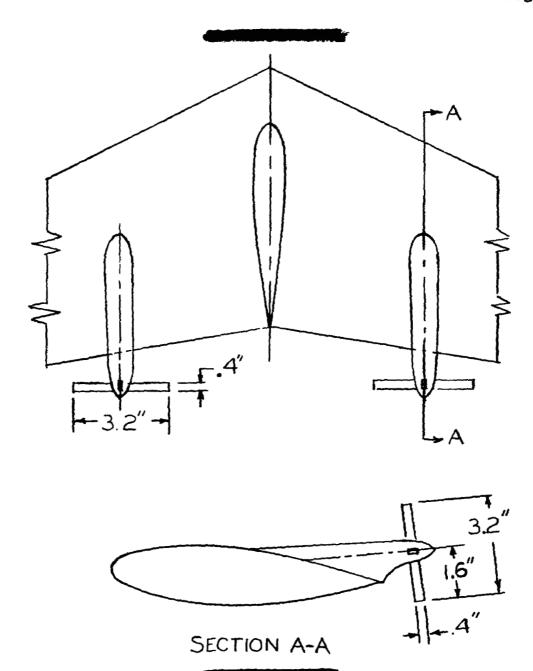
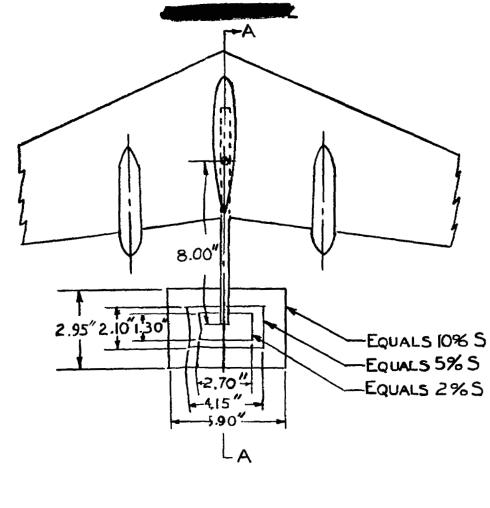


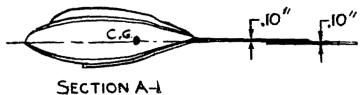
FIGURE 5.- EQUIVALENT PROPELLER FIN AREA AS TESTED ON THE 20 SCALE MODEL OF THE NORTHROP N-9M AIRPLANE.

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS









NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

FIGURE 6.-INSTALLATION OF HORIZONTAL AREAS ON A 20-SCALE MODEL OF THE NORTHROP N-9M AIRPLANE.

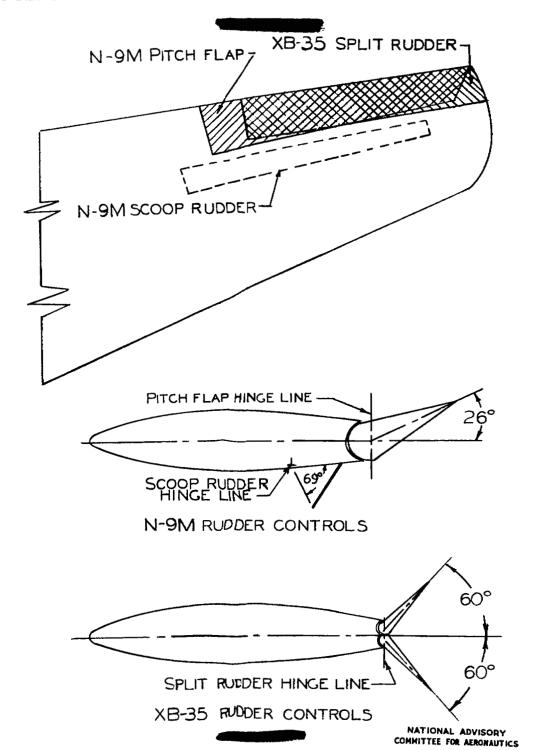
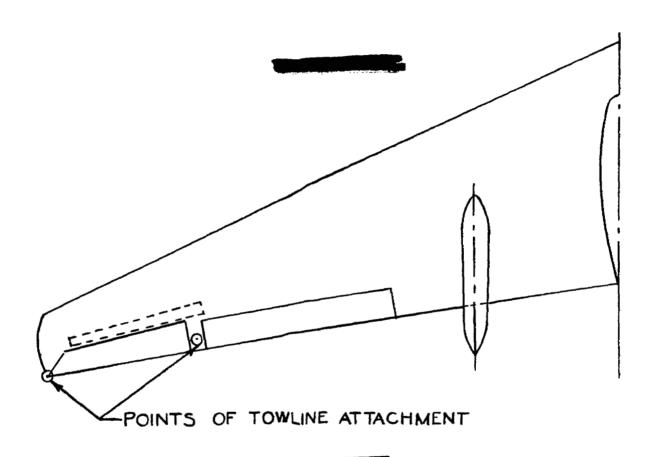


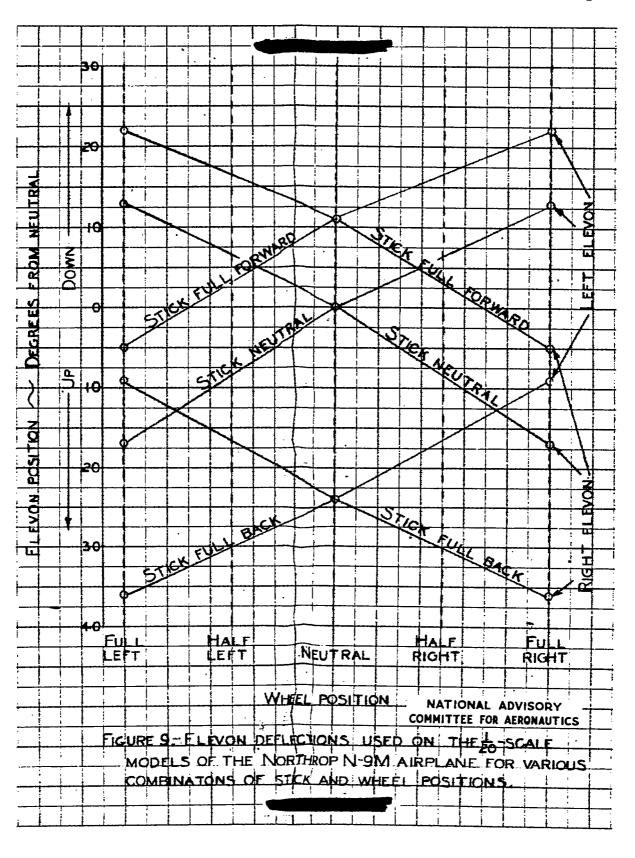
FIGURE 7.- COMPARISON OF THE RUDDER CONTROLS OF THE NORTHROPN-9M AND XB-35 AIRPLANES.





ATTACHMENT FOR THE PARACHUTE TESTS ON A 1/20 - SCALE MODEL OF THE NORTHROPN-9M NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS







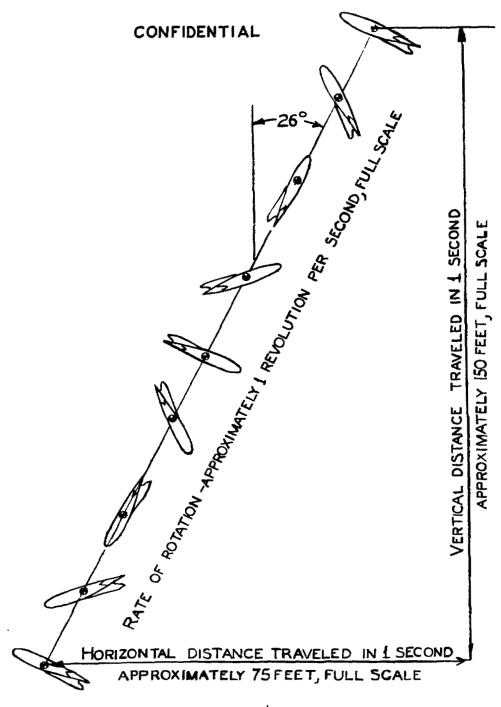
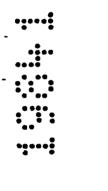


FIGURE 10 - TYPICAL PATH OF THE & -SCALE MODELS OF THE NORTHROP N-9 M AIRPLANE DURING A TUMBLE. NATIONAL ADVISORY CONFIDENTIAL

COMMITTEE FOR AERONAUTICS



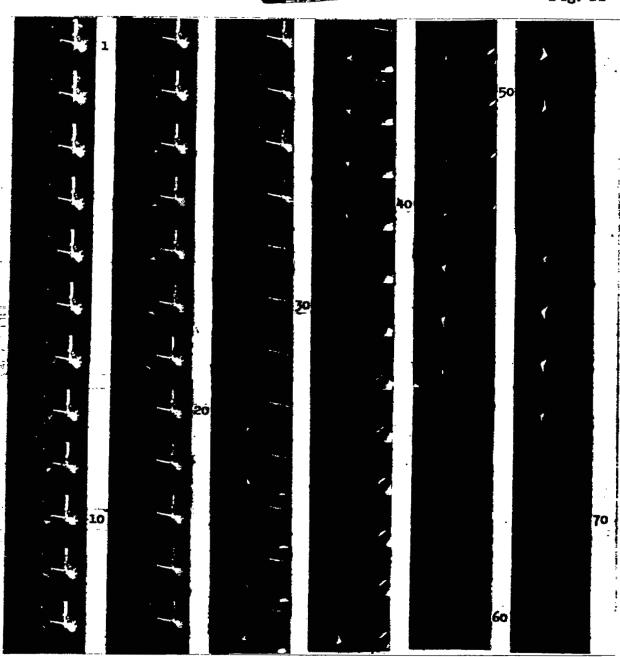
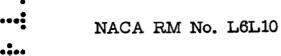


Figure 11.- Typical tumble of the $\frac{1}{20}$ -scale models of the Northrop N-9M

airplane when released from a nose-up attitude. Clean configuration, stick full back, wheel neutral, scoop rudders and pitch flaps neutral. Camera speed, 64 frames per second. Velocity of airstream, approximately 75 feet per second, full-scale.

LANGLEY MEMORIAL AERONAUTICAL LABORATORY - LANGLEY FIELD. VA.





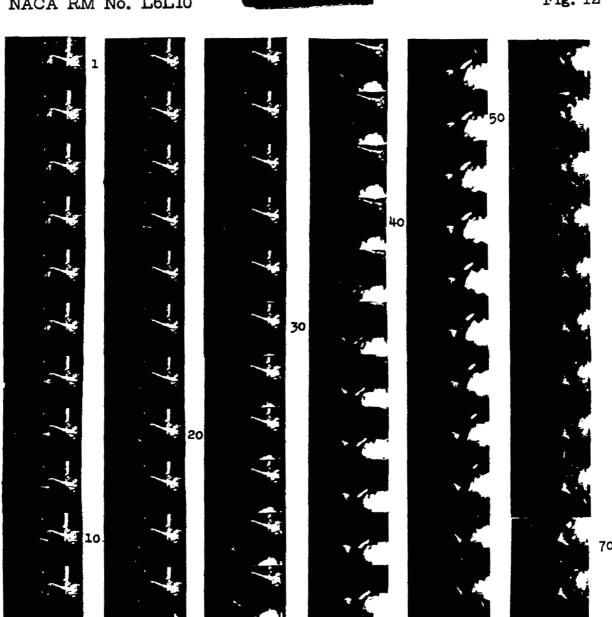


Figure 12.- Typical oscillatory motion of the $\frac{1}{20}$ -scale models of the Northrop N-9M airplane when released from a nose-up attitude. Clean configuration, stick neutral, wheel neutral, scoop rudders and pitch flaps neutral. Camera speed, 64 frames per second. Velocity of airstream, approximately 75 feet per second, full-scale.

60

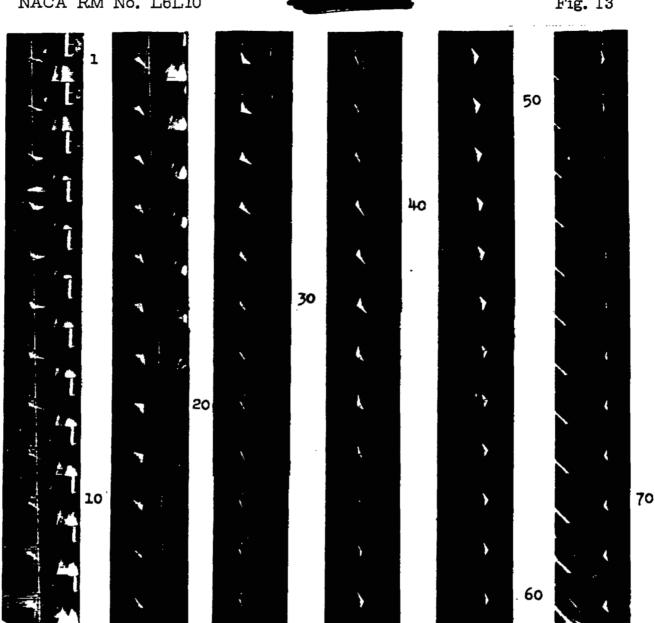


Figure 13.- Typical action of parachutes in producing recovery from an established tumble on the $\frac{1}{20}$ -scale models of the Northrop N-9M airplane. Clean configuration, stick neutral, wheel neutral, scoop rudders and pitch flaps neutral. Camera speed, 64 frames per second. Velocity of airstream, approximately 85 feet per second, full-scale. Towlines attached to rear portion of wing tips. Parachute diameter, 7 feet fullscale. Parachute drag coefficient, approximately 0.7. Towline length, 10 feet full-scale.

